

QUANTIFYING THE EFFECT OF HUMIDITY ON AEROSOL SCATTERING WITH A RAMAN LIDAR

Raymond Rogers, Kevin McCann, Raymond Hoff - UMBC/JCET

Introduction:

The changing scattering properties of aerosols due to water vapor are a significant unknown quantity in the aerosol indirect effect. It is important to understand how these properties behave, especially the humidification of anthropogenic aerosols. Several studies have demonstrated the use of a lidar to help quantify this effect (Feingold, Ferrare). In the experiment described in this poster, a Raman lidar is used to simultaneously measure profiles of extinction and water vapor. From these measurements, taken during the daytime, the effect of the hygroscopic growth of suburban aerosols on aerosol scattering and extinction are determined. The measured results are then compared to simulated measurements.

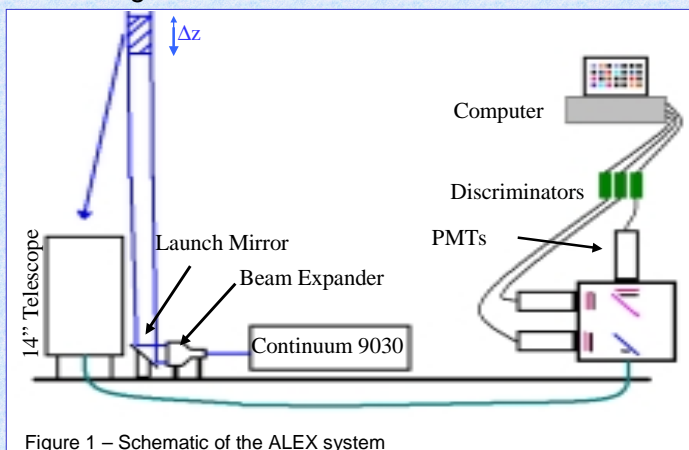


Figure 1 – Schematic of the ALEX system

Measurements and Simulation:

The Atmospheric Lidar Experiment (ALEX), schematic in figure 1, is a Raman lidar that measures profiles of extinction, backscatter, and water vapor mixing ratio with 30 m resolution.

Mie theory routines were combined with a growth model described to obtain the light scattering coefficients as functions of relative humidity (Hanel). The input to the Mie simulation are shown in figure 2. The imaginary index of refraction was assumed to follow behavior similar to the real part, going from 0.05 to 0.001 with relative humidity.

Selected References:

- Feingold, G. and B Morley, 2003: Aerosol hygroscopic properties as measured by lidar and comparison with in-situ measurements," *J. Geophys. Res.*, **108**, D11, 4327.
- Ferrare, R, 1997: The applicability of a scanning Raman lidar for measurements aerosols and water vapor, PhD Thesis, University of Maryland, College Park.
- Hanel, G., 1976: The properties of atmospheric aerosol particles as functions of relative humidity at thermodynamic equilibrium with surrounding moist air, *Geophys.*, **19**, 73-188.

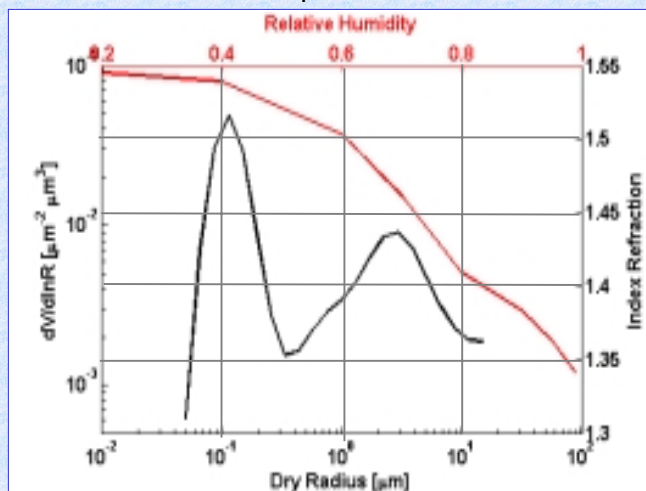


Figure 2 – Real index of refraction vs relative humidity (red) and size distribution vs dry radius (black) from AERONET.

Results and Discussion:

In a well mixed atmosphere, any change in extinction must be due to change in temperature, thus relative humidity, so the extinction and relative humidity profiles are directly compared in figure 3. These data are from several profiles taken during the daytime on June 24, 2004.

These data show the increase in extinction due to water uptake by the aerosol particles, also in good agreement with the simulated growth model as well as decent agreement by Zhang's square law approximation.

Zhang, X., B. Turpin, P. McMurry, S. Hering, and M Stolzenburg, 1994 : Mie theory evaluation of species contributions to 1900 wintertime visibility reduction in the Grand Canyon." *J. Air Waste Manage. Assoc.*, **44**, 15.3-162.

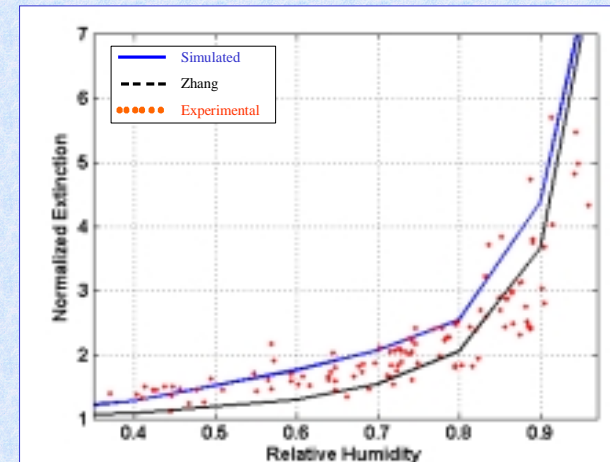


Figure 3 – Simulated (blue), Zhang's approximation (black) and measured (red) normalized extinction vs. relative humidity. These curves are normalized to extinction at 30% relative humidity.

Conclusions and Future Work:

A Raman lidar has been successfully used to measure the hygroscopic properties of aerosols during the daytime. The hygroscopic growth factor, a key element in the aerosol indirect effect, has been estimated for this case to be 2.1.

Future work will include expansion of the UMBC database of growth cases, looking at seasonal dependence of the growth curve, as well as developing a better understanding of the sensitivity of the simulated data.

Acknowledgements:

This work was supported by a City College of New York Research Foundation Grant (49866-00-01C) and by a grant from NASA Langley (NAS1-99107).

Thanks to Brent Holben and all for establishing and maintaining the AERONET site used in this poster.